DOCUMENT RESUME

ED 064 142 SE 013 895

AUTHOR Olsen, Robert Charles; Lockard, J. David
TITLE A Comparative Study of the Effect of Behavioral Objectives on Class Performance and Retention in Physical Science.
PUB DATE Apr 72
NOTE 18p.; Paper presented at the National Association for Research in Science Teaching Annual Meeting, Chicago, Illinois, April 1972

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Achievement; *Behavioral Objectives; Evaluation; *Physical Sciences; *Retention; *Secondary School Students
IDENTIFIERS NARST

ABSTRACT

Presented at the annual meeting of the National Association for Research in Science Teaching (NARST) in April, 1972, in Chicago, this study compared the achievement and retention of ninth grade physical science classes receiving instruction with a prior knowledge of behavioral objectives with ninth grade classes taught the same material without prior knowledge of the objectives. The resultant data indicated that classes with a prior knowledge of the objectives did achieve significantly higher on the achievement test and retention test employed. (Author/CP)

A COMPARATIVE STUDY OF THE EFFECT OF BEHAVIORAL OBJECTIVES ON CLASS PERFORMANCE AND RETENTION IN PHYSICAL SCIENCE

Robert Charles Olsen
Ridgewood Public Schools
Ridgewood, New Jersey

J. David Lockard
Science Teaching Center
University of Maryland

A Paper Presented at the Forty-Fifth
Annual Meeting of the National Association for
Research in Science Teaching

April 4-6, 1972
Chicago, Illinois

INTRODUCTION

During the last decade the schools of our nation have investigated new classroom materials and different methods of instruction in their attempt to increase learning effectiveness. Of the numerous methods of instruction that have been proposed, one which is currently being investigated by science educators is that of the behavioral approach to learning.

Advocates of behavioral objectives for education such as Walbesser (1970), Mager (1962), and Popham (1969) have called for curriculum development using measurable objectives written in behavioral form.

The literature is replete with articles concerning the utilization of behavioral objectives. However, the reported classroom research on the effectiveness of using behavioral objectives in instruction is far from complete.

This investigator believed, therefore, that research needed to be accomplished with classes to ascertain the relative value of the behavioral objective approach to learning.

Statement of the Problem

The problem of this study was to compare the achievement and retention of ninth grade physical science classes receiving instruction with a prior knowledge of behavioral objectives with ninth grade classes taught the same material without prior knowledge of the objectives.

This investigation was conducted to answer the following questions:

1. Does prior knowledge of the behavioral objectives for a given unit in the physical sciences alter class performance on an achievement test?
2. Does prior knowledge of the behavioral objectives for a given unit in the physical sciences alter class performance on a retention test?

Statement of the Research Hypotheses

1. The mean scores of classes studying IME Science (Interaction of Matter and Energy), as measured by the Achievement Test, will be higher for those classes provided with behavioral objectives prior to instruction than for those classes not provided with the objectives.

2. The mean scores of classes studying IME Science, as measured by a Retention Test, will be higher for those classes provided with behavioral objectives prior to instruction than for those classes not provided with the objectives.

Subjects

Fourteen ninth grade physical science classes from the two junior high schools of the Ridgewood Public School System participated in the study. A total of 306 students completed the experiment. Ridgewood, New Jersey, is a suburban residential community of approximately 30,000 inhabitants located in the Northwest portion of Bergen County, twenty-one miles from New York City.

Experimental Design

This experiment was designed to assess the effects of behavioral objectives on class achievement and retention. The experimental classes received instruction in physical science with stated behavioral objectives and the control classes received physical science instruction without knowledge of the objectives.

Eighteen behavioral objectives and thirty-six assessment tasks were constructed by the investigator and evaluated by ten science educators. Nine action verbs were used. They were: apply the rule, construct, distinguish, demonstrate, describe, identify, order, predict and state a rule. (Walbesser, 1966). The behavioral objectives are included as Appendix A.

The subject matter studied in this experiment dealt with energy transfer, phases of matter, heat energy and light energy as found in chapters ten, eleven, twelve and thirteen of the science program IME (Interaction of Matter and Energy). (Abraham, etal, 1969). The subject matter content used with both experimental and control groups was the same; however, stated behavioral objectives with assessment tasks were used in the experimental classes. The variable measures in this experiment were the mean scores obtained by the classes on the following instruments.

Instruments Used to Measure the Variables

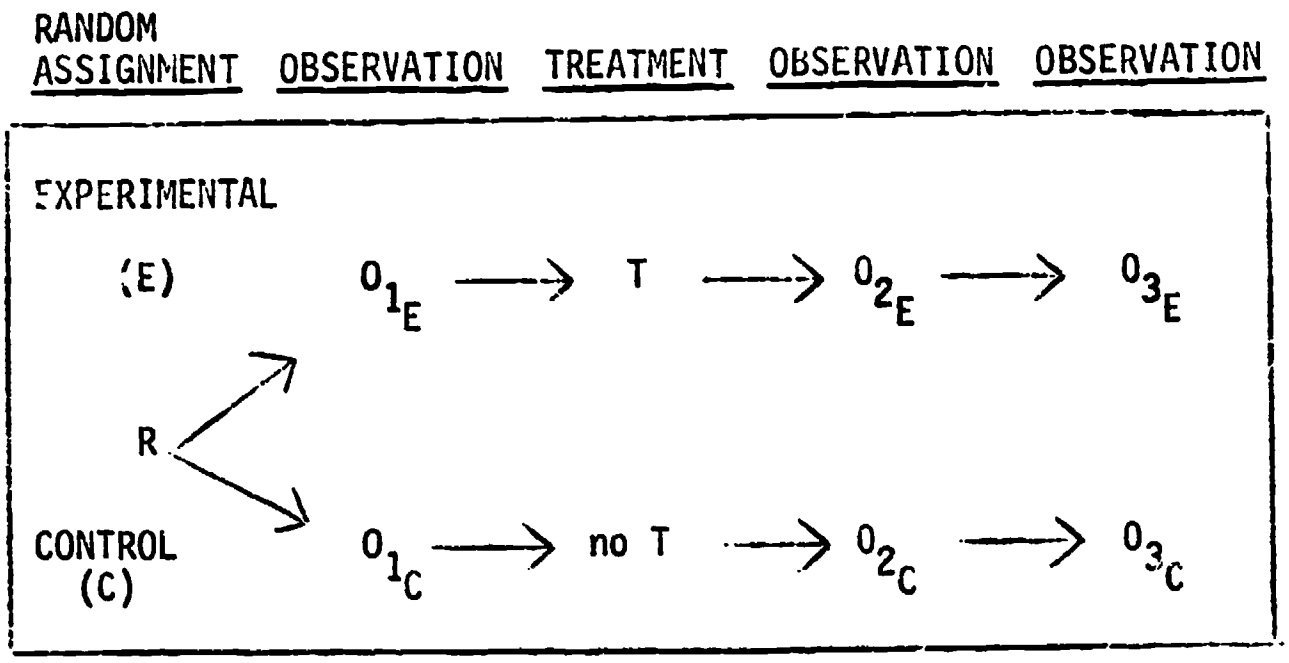
The STEP (Sequential Test of Educational Progress) was used to measure the entering performance level of all subjects

prior to the start of the experimental study. The test is designed to measure a wide range of understanding and skills related to performance in science. The STEP test in science, Form 3-A, Series II, is a fifty-item, multiple choice test with a reported reliability coefficient of 0.89, and a standard error of 2.9 (Educational Testing Service, 1970, pg. 30).

The IME (Interaction of Matter and Energy) quarterly and final achievement tests were designed by Rand McNally & Company. Each of the IME quarterly and final achievement tests are fifty-item, multiple choice examinations reporting reliability coefficients (Kuder Richardson Formula 21) Ranging from 0.832-0.867 (IME - Interaction Newsletter, Number 5, 1969, pg. 7).

Statistical Design

The research design considered appropriate for this study was Campbell and Stanley's (1966) control group design number ten in which the intact groups constitute naturally assembled classes. With subjects in pre-assembled classes it was necessary to randomly assign the treatments to the intact classes. To control any differences in student ability in the two groups of classes, experimental and control, the analysis of covariance was used to statistically control any differences. The classroom mean score was used as the unit of analysis.



E = Experimental classes received treatment of Behavioral Objectives.

C = Control classes did not receive the Behavioral Objectives.

R = Random assignment of treatment to intact groups.

O_1 = STEP Test used as Pretest.

O_2 = Achievement Test.

O_3 = Retention Test.

The formal testing began at Ridgewood Schools in January, 1971. At this time the Otis-Lennon Mental Ability Test, Form J,was administered to all ninth grade students by the guidance department.

The STEP - Sequential Test of Educational Progress: Form 3 A, was administered to all IME classes to measure the entering performance level in science of all subjects in the sample prior to the start of the experiment. Two weeks following the administration of the STEP Test, the instructional program began in all classes.

The behavioral objectives for each chapter were given to the experimental classes, one chapter at a time. Following this initial overview of the chapter's objectives, assessment task sheets were provided, one objective at a time, to insure a more complete exposure and reinforcement for each of the behavioral objectives.

At the conclusion of the three month instructional period, the IME third unit Achievement Test was administered to all 14 class sections. The achievement test papers were machine scored and the scores placed on punched cards for computer analysis. Fourteen sets of data were analyzed using the following computer programs: (1) ANOVA-Analysis of Variance, developed at the University of California - BMD-01V and BMD-01D, (2) ANCOVA-Analysis of Covariance with homogeneity of regression test, developed by Dr. C. Mitchell Dayton at the University of Maryland, and (3) MANOVA-Multivariate Analysis of Variance, developed at the Biometric Laboratory, University of Miami.

The analysis of covariance tested the effect of treatment on achievement and retention for the experimental and control classes. This analysis is particularly useful since it is the blending of regression and the analysis of variance which permits statistical rather than experimental control of the variables.

After three weeks, the Retention Test was administered to all 14 classes to compare the experimental and control groups in terms of the amount of "forgetting". The retention

scores were also submitted to the computer for statistical analysis.

Findings

Four measures were obtained on each subject in the experimental and control classes. The mean scores for the experimental and control classes are illustrated in Tables one and two.

TABLE 1

MEAN SCORES AND STANDARD DEVIATION *
FOR THE EXPERIMENTAL GROUPS ON THE
FOUR MEASURES

GROUP	N	STEP	IQ	ACHIEVEMENT	RETENTION
1	21	78.09 (10.22)	110.04 (9.06)	65.61 (10.65)	61.14 (10.66)
2	21	75.61 (14.24)	113.33 (11.64)	68.28 (9.96)	67.80 (9.75)
3	18	76.11 (14.75)	112.55 (18.04)	66.33 (16.69)	66.44 (15.22)
4	26	73.38 (13.29)	108.57 (11.63)	65.15 (12.97)	65.07 (10.94)
5	21	76.33 (11.76)	113.95 (12.26)	65.23 (14.60)	64.95 (12.19)
6	23	77.91 (13.21)	116.13 (12.51)	70.26 (14.48)	70.08 (13.90)
7	27	78.95 (11.79)	115.48 (12.63)	70.37 (10.92)	67.48 (11.44)
8	23	84.60 (7.82)	117.86 (13.17)	73.82 (12.08)	68.86 (12.58)

* - Standard Deviation Scores in Parentheses.

TABLE 2

MEAN SCORES AND STANDARD DEVIATION*
FOR THE CONTROL GROUPS ON THE
FOUR MEASURES

GROUP	N	STEP	IQ	ACHIEVEMENT	RETENTION
1	22	75.63 (13.54)	112.68 (15.59)	62.27 (13.65)	55.01 (19.18)
2	22	76.00 (12.46)	116.54 (12.61)	61.00 (9.88)	54.11 (13.89)
3	25	75.36 (15.29)	113.04 (13.34)	53.92 (16.75)	51.68 (15.53)
4	16	76.75 (13.73)	115.06 (12.56)	58.37 (10.63)	53.00 (14.12)
5	17	82.47 (9.73)	118.58 (11.90)	63.41 (10.43)	62.58 (14.41)
6	24	82.83 (9.02)	119.45 (8.16)	66.08 (11.33)	60.83 (13.08)

* - Standard Deviation Scores in Parentheses.

Results

The experimental group obtained higher mean scores than the control group on both achievement and retention tests. The overall mean differences were found to be statistically signigicant at the .01 level of confidence using the Fisher F Test with the analysis of covariance. In regard to the hypotheses tested, the following is reported:

HYPOTHESIS 1. $H_o : \mu_{E_{ach.}} = \mu_{C_{ach.}}$

There is no significant difference in achievement as measured by the IME Achievement Test three, between the Experimental ninth grade classes provided with the behavioral objectives prior to instruction and the ninth grade Control classes not provided with the objectives.

To test this hypothesis, the analysis of covariance technique was used since adjustments for pre-test differences between the experimental and control groups on the dependent variable can be statistically controlled. The covariates were the IQ and STEP scores.

Assumption of homogeneity of regression was tested and accepted before proceeding with analysis of covariance.

TABLE 3

ANALYSIS OF COVARIANCE

OF THE ACHIEVEMENT SCORES

FOR ALL CLASSES

SOURCE	DF	SS*[1]	MS	F	p
Treatment	1	197.860	197.860	37.784	< .001
Regression	2	106.565	53.283	10.175	< .004
Within	10	52.366	5.237		

1 - SS* indicates Sums of Squares on adjusted criteria scores.

The data presented in Table 3 show the analysis of covariance on the achievement scores. The adjusted mean scores for experimental and control groups were 68.13 and 60.84 respectively. The difference between these two values was statistically significant beyond the 0.01 level.

HYPOTHESIS 2. $H_o : \mu_{E_{ret.}} = \mu_{C_{ret.}}$

There is no significant difference in retention as measured by the Final Test (selected test items appropriate to the third unit material) between the experimental ninth grade classes provided with behavioral objectives prior to instruction and the ninth grade control classes not provided with objectives.

The investigator felt, as with hypothesis 1, that analysis of covariance should be used to test hypothesis 2 since any difference in experimental groups could be statistically controlled by using the IQ and STEP scores as covariates. Assumption of homogeneity of regression was tested and accepted.

The data presented in Table 4 show the analysis of covariance on the retention scores. When the effects of IQ and STEP Test were removed by covariance, the adjusted mean scores for experimental and control groups were 66.48 and 56.19 respectively. The difference between these two values was statistically significant beyond the 0.01 level.

TABLE 4

ANALYSIS OF COVARIANCE

OF RETENTION SCORES

FOR ALL CLASSES

SOURCE	DF	SS*[1]	MS	F	p
Treatment	1	383.64	383.64	61.90	<.001
Regression	2	91.33	45.66	7.36	<.011
Within	10	61.97	6.19		

1 - SS* indicates Sums of Squares on adjusted criteria scores.

Discussion and Conclusion

The data of this investigation indicated that classes receiving instruction with a prior knowledge of the objectives did achieve significantly higher on the Achievement Test and Retention Test employed.

A closer examination of the data, as in Table 5, revealed some interesting information. When the means of mean scores for experimental and control groups were compared, a difference favoring the control groups was noted in the pre-test measure of IQ and STEP Test.

The post-test data in the area of achievement and retention revealed a difference favoring the experimental groups, a difference as was noted earlier, which was significant beyond the .01 level.

TABLE 5

MEANS OF MEAN SCORES

FOR EXPERIMENTAL

AND CONTROL GROUPS

ON THE FOUR MEASURES

Instrument	Experimental	Control	Difference (X-Y)
STEP	77.62	78.17	- .54
IQ	113.49	115.89	- 2.40
ACHIEVEMENT	68.13	60.84	+ 7.29
RETENTION	66.48	56.19	+ 10.29

The results of the study support the thesis that providing classes with behavioral objectives prior to instruction can enhance the performance on achievement tests. Also, the data strongly suggest that behavioral objectives and their accompanying assessment tasks will cause a resistance to forgetting.

Within the limitations of this study, the use of behavioral objectives proved effective in achievement and retention with the defined experimental classes. However, there are mixed findings in the literature dealing with behavioral objectives being used by "students" in independent study and programmed instruction. Thus,the results of this study, in which "classes" were provided with the behavioral objectives, suggest a different direction in the utilization of behavioral objectives in instruction.

APPENDIX A

BEHAVIORAL OBJECTIVES

10-1. Order the states of matter.

10-2. Demonstrate how to calibrate an unscaled thermometer.

10-3. Construct a Model of a mulecule.

10-4. Predict the behavior & orientation of molecules under stated conditions.

10-5. Apply the Rule that the particles of solute interact with particles of solvent to cause a reduction in temperature.

11-1. Apply the kinetic theory to explain a phenomenon in which a system's temperature is increased when work is done on it.

11-2. State an operational definition for specific heat.

11-3. Demonstrate the ability (a procedure) to calculate the energy used (lost or gained) to change water from one temperature to another.

11-4. Apply the rule that the mass of an object does not change when heated.

11-5. Describe a model to explain the rate of temperature change for a thermometer wrapped in cloth and soaked with different solutions.

11-6. Construct a graph that will illustrate the temperature change of two substances with respect to time.

11-7. Describe the flow of heat energy from regions of high temperature to regions of low temperature.

12-1. Distinguish between the distance that the image of an object appears to be "behind" a mirror with the actual distance from the object to the mirror.

12-2. Demonstrate the relationship between the angle at which light strikes a mirror and the angle at which light is reflected.

12-3. Construct a diagram which will show the behavior of light passing through different substances.

13-1. Identify the behavior of light based on the wave model.

13-2. Order the waves from the shortest to the longest wavelength.

13-3. Describe interference patterns in wave phenomena.

The illustrations and expanded form of the behavioral objectives have been omitted from this abstract.

BIBLIOGRAPHY

Abraham, Norman; Balch, Patrick; Chaney, Donald and Lawrence M. Rohrbaugh. Interaction of Matter and Energy. Rand-McNally and Company, Chicago, 1969.

Campbell, D. T. and Stanley, J.C. Experimental and Quasi-Experimental Designs For Research. Rand McNally and Company, Chicago, 1966.

Dayton, C. Mitchell. "Computer Program-ANCOVA, with Homogeneity of Regression Test", University of Maryland, 1963.

Dixon, Wifrid J. BMD Biomedical Computer Programs. Berkeley: University of California Press, 1968.

Educational Testing Service. Book of Norms - STEP Tests, Princeton, New Jersey, 1970, pg. 30.

Interaction of Matter and Energy, IME Newsletter, No. 5. Rand McNally and Company, 1969, pg. 7.

Mager, Robert F. Preparing Instructional Objectives. Palo Alto, California: Fearon Publishers, 1962.

Popham, James. Objectives and Instruction. AERA Monographs on Curriculum Evaluation, Vol. 3, Chicago: Rand McNally Company, 1969.

Walbesser, Henry H. "Science Curriculum Evaluation: Observations on a Position", The Science Teacher, 33, February 1966, 34-39.

Walbesser, Henry H. Constructing Behavioral Objectives. College Park, Maryland; Bureau of Educational Research and Field Services, University of Maryland, 1970.